NHMFL

FLORIDA STATE UNIVERSITY

SAFETY PROCEDURE

SP-21

TITLE: LASER SAFETY PROCEDURE

1.0 PURPOSE

1.1 This procedure establishes policy to be observed by all personnel at the NHMFL when operating lasers or laser systems during experimentation and research.

1.2 The policy of the NHMFL is to provide and maintain a safe and healthful working environment. Employees and users alike shall assist in ensuring that safety is not compromised. The safety and health of employees and users is the inherent responsibility of each employee, user, management, and all levels of supervision.

2.0 SCOPE

This document assigns responsibilities, provides safety guidance, and defines actions to be taken to protect workers from the hazards involved with the use of lasers and laser systems.

3.0 RESPONSIBILITIES

3.1 The NHMFL Laser Safety Committee has the responsibility for the overall administration of this procedure. The Committee shall review and approve all requests for laser installation and operation. Modifications to lasers or lasers systems shall be approved by the Committee. The Committee shall approve the appointment of the Laser Safety Officers for each department.

3.2 The NHMFL Safety Office shall act as a liaison between the Laser Safety Committee and the Principal Investigators, LSO, laser users, and operators. The Safety Office shall evaluate the effectiveness of this safety procedure and make the necessary revisions to ensure the safety of all personnel at the NHMFL. The Safety Office shall develop and administer safety training programs and maintain the training records. The Safety Office shall ensure that all laser and laser systems are properly registered prior to the initial operation.

3.3 The Florida State University Environmental Health and Safety Office has the responsibility for assisting the NHMFL Safety Office in the development and maintenance of the procedure.

3.4. The Laser Safety Officer (LSO), generally the Principal Investigator involved with the research, or his delegate, has the following responsibilities for NHMFL personnel:

3.4.1 Enforce the laser safety standards of this procedure and ensure that they are followed at all times.

3.4.2 Ensure proper registration of all laser systems and laser operators. Contact the Safety Office for assistance in obtaining the necessary forms and applications. (See section 4.2)

3.4.3 Provide for proper supervision of all spectators, visitors and personnel having access to the facility to ensure against unauthorized entrance or accidental exposure to laser radiation.

3.4.4 Ensure all personnel under their supervision have received the proper medical monitoring prior to laser use, have submitted a copy of the surveillance results to the NHMFL Safety Office, and have received the proper training on the safe use of lasers.

3.4.5 Ensure that any corrective items noted following an inspection are completed in a timely manner and reported to the NHMFL Laser Safety Committee.

3.4.6 Report all incidents involving injury or a safety violation to the NHMFL Safety Office.

3.4.6 Report new personnel working under their supervision to the Safety Office.

3.5 Laser operators or technicians shall be responsible for the safe operation of lasers and laser system and for those personnel in their immediate work area. The use of personal protective equipment shall be required when operating a laser or laser system or when within the laser controlled area. Operators and technicians shall be available to assist in performing surveys and inspections. All operators and technicians shall be subject to an initial eye exam to determine a baseline. Operators and technicians shall attend all safety training programs as requested by the NHMFL Safety Office.

3.6 The NHMFL Operations Department shall ensure that all outside users of the NHMFL facilities have been properly trained in all aspects of this procedure prior to being allowed to operate any laser or laser system. Outside users may provide previous records of medical surveillance and training in the safe use of lasers as evidence of meeting the requirements of this safety procedure. These records shall be available to the NHMFL Safety Office upon request. A copy of the NHMFL Laser Safety Procedure shall be available to users upon request.

4.0 SAFETY

4.1 Definitions applicable to this procedure:

4.1.1 *Class I*: A laser or laser system containing a laser, that cannot emit accessible laser radiation levels in excess of the Class I accessible emission limit (AEL) for the maximum possible duration inherent in the design or intended use of the laser or laser system.

4.1.2 *Class II*: A low power visible light laser or laser system which can emit radiant power exceeding Class I for the maximum duration inherent in the design or intended use of the laser, but not exceeding one mW or , in the

case of a repetitively pulsed laser, not exceeding a Class I accessible emission limit for a 0.25 second exposure.

4.1.3 *Class IIa*: A low power visible light laser or laser system which is intended for a specific use where the output is not to be viewed and does not exceed the Class I accessible emission limits for a duration not less than or equal to 10^3 seconds.

4.1.4 *Class IIIa*: A medium power laser or laser system which has an output power between one and five times the Class I accessible emission limits for wavelengths less than 0.4 micrometers or greater than 0.7 micrometers, or the Class II accessible emission levels for wavelengths greater than 0.4 micrometers and less than 0.7 micrometers.

4.1.5 *Class IIIb*: A medium power laser or laser system which has an output power greater than that defined for Class IIIa, but having levels less than 0.5 W for all continuous wave laser types for periods greater than or equal to 0.25 seconds or having levels less than 10 J cm^{-2} for exposures less than 0.25 seconds.

4.1.6 *Class IV*: Includes ultraviolet (0.18 to 0.4 um) and infrared (1.4 um to 1 mm) lasers and laser systems which (a) emit an average accessible radiant power in excess of 0.5 W for periods $\geq$ 0.25 s or (b) produce a radiant energy greater than 0.125 J within an exposure time of < 0.25 s. Also, visible (0.4 to 0.7 um) and near-infrared (0.7 to 1.4 um) lasers and laser systems which (a) emit an average accessible radiant power of 0.5 W or greater for periods $\geq$ 0.25 s or (b) produce radiant energy in excess of $0.03C_A$ J.

4.1.7 *Controlled Area*: An area where the occupancy and activity of those within is subject to control and supervision for the purpose of protection from radiation hazards.

4.1.8 *Control Disconnect*: Any device which will turn off the laser or terminate the beam. The laser power supply can serve as a control disconnect if it is located outside the controlled area.

4.1.9 *Facility*: Any location where one or more lasers or laser systems are used or operated.

4.1.10 *Incident*: An event or occurrence which results in real or suspected accidental exposure to laser radiation that caused or is likely to cause biological damage.

4.1.11 *Ionizing Radiation*: Electromagnetic radiation having a sufficiently large photon energy to directly ionize atomic or molecular systems with a single quantum event.

4.1.12 *Laser*: A device which produces an intense, coherent, directional beam of light by stimulating electronic or molecular transitions to lower

energy levels. An acronym for Light Amplification by Stimulated Emission of Radiation.

4.1.13 *Laser Personnel*: Any person who actively engages in the operations of a laser or laser system, including the installation, aligning, and firing of a laser or laser system.

4.1.14 *Laser Safety Officer (LSO*): One who has authority to monitor and enforce the control of laser hazards and effect the knowledgeable evaluation and control of laser hazards. The Principal Investigator will be the LSO for those personnel directly under his or her supervision and the Safety Coordinator and the Hazardous Materials Manager shall act as the LSO for the NHMFL.

4.1.15 *Laser System*: An assembly of electrical, mechanical, and optical components which includes a laser.

4.1.16 *Maximum Permissible Exposure (MPE*): The level of laser radiation to which a person may be exposed to without hazardous effects or adverse biological changes in the eye or skin.

4.1.17 *Power*: The rate at which energy is emitted, transferred, or received. Unit: watts (joules per second).

4.1.18 *Protective Housing*: An enclosure that surrounds the laser or laser system that prevents access to laser radiation above the applicable MPE level. The aperture through which the useful beam is emitted is not part of the protective housing.

4.1.19 *Spectator*: An individual who wishes to observe or watch a laser or laser system in operation, and who may lack the appropriate laser safety training.

4.1.20 *Wavelength*: The distance between two successive points on a periodic wave which have the same phase.

4.2 Registration

All lasers of Class II power or above must be registered with the Department of Health and Rehabilitative Services and with the Florida State University Radiation Safety Office prior to installation and initial operation. Items to be completed on the registration form include identifying the lasing medium, class, type (continuous wave or pulse), wave length, power (joules or watts), manufacturer, name and signature of registrant, location of device, and name of LSO. The NHMFL Safety Office will assist with the registration process.

4.3 Medical Surveillance and Monitoring

4.3.1 All operators of Class IIIb and IV lasers or laser systems must have an initial eye exam performed by a licensed optometrist prior to using such lasers. The exam may include a visual acuity for far and near vision, on ocular history, tests for macular function, color vision, and fundoscopy test. The results of this exam will be used to establish a basis from which to measure eye damage, should a laser accident

involving damage to the eye occur. An eye exam shall be offered to personnel terminating their employment with the NHMFL.

4.3.2 Incidental personnel, such as custodial, clerical or supervisory positions, may have an eye exam if there is reason to believe that an exposure to laser radiation has occurred above the MPE. Contact the Safety Office if you have been exposed to laser radiation.

4.3.3 Arrangements have been made through the University's Student Health Services to perform the exam. Appointments can be set up by contacting the NHMFL Safety Office. The department to which the laser personnel are assigned is responsible for funding all required eye exams.

4.4 Personal Protective Equipment

4.4.1 Enclosure of the laser equipment or beam path is the preferred method of control, since the enclosure will isolate or minimize the hazard. Personal protective equipment is necessary when these control measures do not provide adequate protection from the direct or reflected beams.

4.4.2 Protective eyewear designed for the specific laser being used must be worn by all individuals having access to Class IIIa, IIIb, or IV laser controlled areas during startups, tests, alignments, and operations. The selection of the eyewear shall be based on the power of the laser or laser system, wavelengths, optical density, lasing medium and class of device.

4.4.3 Protective gloves and clothing must be worn during the operation of Class IV lasers where the possibility exists for laser injury to parts of the body other than the eye.

4.4.4 Respiratory protection, including dust masks and air purifying respirators, may be necessary if engineering controls, such as ventilation equipment, do not reduce airborne contaminants below acceptable levels.

4.4.5 Periodic cleaning and inspection shall be made of protective eyewear to ensure the maintenance of satisfactory condition. Damaged eyewear shall be discarded and replaced. Protective eyewear shall be stored so as to prevent damage to the lenses and frames. Avoid storing in direct sunlight and protect from chemical exposures. Refer to the manufacturer's recommendations for proper inspection and cleaning techniques.

4.4.6 The LSO and the NHMFL Safety Office are responsible for supplying any necessary personal protective equipment and training personnel on the safe use of the equipment. The LSO and the Safety Office shall ensure that personnel are wearing the proper PPE when necessary.

4.5 Safety Training

The NHMFL will develop and administer the safety training programs for laser operators, technicians, LSO, and incidental personnel not at risk of exposures to laser radiation. Operators, technicians and LSO's shall receive training prior to the assignment to work with lasers or laser systems. A refresher training program shall be offered yearly. The

training program will emphasize the general safety aspects of laser use, including safe work practices, engineering controls, personal protective equipment, and accident reporting. Incidental personnel at limited risk to an exposure may receive training on awareness and avoidance of areas containing lasers or laser system.

4.6 Maintenance

Maintenance and service of lasers and laser systems shall be performed by authorized maintenance personnel for all classes of lasers. All equipment shall be properly de-energized prior to proceeding with any maintenance tasks. The LSO shall be responsible for arranging for maintenance and service.

4.7 General Laser Safety Rules

The general rules below must be followed by all laser personnel, visitors, users and spectators to ensure maximum safety.

4.7.1 Education and training shall be provided for all laser personnel prior to assignment to working with a laser or laser system.

4.7.2 The manufacturer's installed protective housings on all classes of lasers and laser systems shall be maintained and shall not be removed when the laser or laser system is operational

4.7.3 Lasers should be operated in well lighted areas when possible. If not possible, safety measures shall be taken to ensure the safety of the personnel in the area. This may include the use of glowing light switches, flashlights, and lighted exit signs to facilitate evacuation in the event of an emergency.

4.7.4 Visual alignment of lasers should not be attempted. If necessary, visual alignment shall be performed by a competent and qualified person. Lasers should be powered down to the lowest practical level during alignment. Only authorized personnel shall be present during alignment operations. If unable to power down the laser or laser system, appropriate control measures and personal protective equipment shall be utilized. During alignment, the primary beam, or a specular or diffuse reflection of a beam, shall not expose the eye to a level above the MPE.

4.7.5 Direct viewing of laser radiation is prohibited and must not be attempted at any time.

4.7.6 Jewelry shall not be worn while operating lasers.

4.7.7 Materials capable of specular reflection should be covered or eliminated.

4.7.8 Flash lamps used with solid state lasers should be shielded.

4.7.9 Never leave an operating laser unattended and never work alone if possible.

4.7.10 Utilize beam shutters or caps when laser transmission is not required.

4.7.11 Servicing of lasers and laser systems must be performed by qualified technicians only.

4.7.12 Equipment shall be inspected prior to any use. Defective equipment shall not be used until repaired.

4.7.13 All warning signs, labels and alarms shall be in place prior to operation. Sign dimensions, letter size and color, etc., shall be in accordance with the American National Standard Institute's recommendations, ANSI Z136.1-1993. Warning signs shall be posted to all access points to a laser controlled area.

4.7.14 Contact the NHMFL Safety Office at 644-0233 or 644-6955 to report all incidents involving lasers.

4.8 Class IIIb and IV Lasers Specific Requirements

4.8.1 Standard operating procedures (SOP'S) shall be developed and posted in a prominent location. These SOP's shall be available to all laser personnel.

4.8.2 Class IIIb and IV lasers shall be provided with a master switch operated by a key, or a coded access system. This switch shall be disabled when the laser or laser system is not intended for use. Only authorized personnel shall have access to the key or coding system. The key, if provided, shall be removed and secured, such as in a key bank, to prevent the unauthorized use of the device.

4.8.3 Interlocks shall be provided on the protective housing. Service access panels shall be interlocked or require a tool for removal and shall have an appropriate warning label. Remote interlock connectors shall be provided.

4.8.4 Permanently attached beam stop or attenuators shall be provided and capable of preventing access to laser radiation in excess of the MPE level when the laser output is not required.

4.8.5 An alarm, such as an audible bell or chime, a warning light visible through protective eyewear, or a verbal "countdown" command for single pulse or intermittent operations shall be used during activation or startup. For Class IV lasers or laser systems, the warning shall be activated a sufficient time prior to emission of the laser radiation to allow for the appropriate protective measures to be taken.

4.8.6 Laser Control Areas shall be established and only authorized personnel shall be admitted into such areas when lasers are operating. The area shall be posted with warning signs and symbols based on the class of laser or laser system. All signs and symbols shall be in accordance with ANSI Z136.1-1993.

4.8.7 Access to Controlled Areas shall be supervised and entry doors shall be closed and locked at all times when the laser is operating.

4.8.8 A blocking barrier, screen, or curtain which can block or filter the laser beam at the entryway should be used inside the controlled area to prevent the laser light from exiting the area at levels above the applicable MPE level. These shall be specifically selected to withstand direct and diffusely scattered beams. Non-flammable and non-toxic materials shall be used.

4.8.9 Spectators shall not be permitted within the laser control area unless approved by the LSO, all hazards are explained, and the proper protective measures are taken.

4.8.10 A "panic button" or control disconnect switch must be available to deactivate the laser in the event of an incident or emergency in the area.

4.8.11 All optical paths (windows, doors) shall be shielded to contain the beam in the controlled area.

4.8.12 The LSO shall require and approve written standard operating procedures (SOP's) and these shall be maintained with the laser equipment and be accessible for reference by operators, and service and maintenance personnel.

4.8.13 When possible, Class IV lasers with exposed beams should be monitored and fired remotely.

4.8.14 All collecting optics such as lenses, telescopes, and microscopes, intended for viewing use with a laser or laser system shall incorporate suitable means, such as interlocks, filters, or attenuators, to maintain the laser radiation transmitted through the collecting optics to levels at or below the appropriate MPE under all conditions of operation and maintenance. (Note: Normal or prescription eyewear are not considered collecting optics.)

4.9 Electrical Hazards

Electrical shock hazards can occur from contact with exposed utility power utilization, device control, and power supply conductors. These hazards can occur during laser set up, installation, maintenance, service, or where protective covers are removed to allow access to active components. When installation or service work is needed on a laser or laser system a qualified electrician shall be present. Contact the Facilities and Administration Department for assistance.

4.10 Laser Generated Air Contaminants (LGAC)

Air contaminants may be generated when certain Class IIIb and IV laser beams interact with matter. These contaminants may be toxic, corrosive, or flammable gases, dusts, mists, or vapors. The LSO shall ensure that the industrial hygiene aspects of exposure to LGAC are addressed and that appropriate control measures are effected. Engineering controls shall be used to eliminate the hazards caused from LGAC. Other control measures include the use of respiratory protective equipment and isolation of the system.

4.11 Other non-beam hazards

Other hazards to be considered with the use of lasers and laser systems include the use of cryogenic gases as coolants, the use of compressed gases, the toxicity and reactivity of the target material, noise levels generated, and arc of the filament lamps.

4.12 Surveys and Inspections

Surveys and inspections shall be conducted prior to the initial start up of a laser or laser system by the NHMFL Laser Safety Committee. Inspections shall be performed randomly, and at a minimum of once a year. The Principal Investigator, or the LSO, shall be made aware of the inspections and surveys and will be asked to be present during the inspection. A report listing deficiencies and corrective items Records shall be maintained in the NHMFL Safety Office.

4.13 Emergency Response Procedures

4.13.1 Response during normal working hours shall include:

a) For minor injuries or suspected exposure to laser radiation, contact the FSU Optometry Clinic at 644-5256 and report that an incident has occurred involving laser radiation and describe any symptoms noted. Transport the injured person to the clinic, located in Room 402 in the Thagard Student Health Center.

b) If transportation is not available or the injury is serious, contact the University Police at 644-1234 or call 9-911 for an ambulance. Describe the injury and arrange to meet the emergency personnel.

c) Report all incidents involving exposure to laser radiation to the NHMFL Safety Office at 644-0233 or 644-6955, or the FSU Radiation Safety Office at 644-8801.

4.13.2 Response after normal working hours shall include:

a) Call the FSU Police or activate the 9-911 system immediately if the injury is serious and requires medical attention and arrange for transportation to Tallahassee Memorial Regional Medical Center.

b) Report the incident to the NHMFL Safety Office by the next working day or contact the Safety Coordinator via pager at 657-8278 or the Hazardous Materials Manager at pager 657-8279.

5.0 REFERENCES

5.1 Florida State University Laser Safety Manual
5.2 American National Standard for Safe Use of Lasers; ANSI Z136.1, 1993